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WAR DEPARTMENT TECHNICAL MANUAL

U.S. Dept. of Army

PUMP, HORIZONTAL DUPLIX PISTON, STEAM DRIVEN SIZE 3 x 2 x 3-IN., 6 GPM ¾-IN. DISCHARGE, ¾-IN. INLET (STEAM) AMERICAN-MARSH MODEL 202-C-1

WAR DEPARTMENT • 3 APRIL 1944

PUMP, HORIZONTAL
DUPLEX PISTON, STEAM DRIVEN
SIZE 3 x 2 x 3-IN., 6 GPM
 $\frac{3}{4}$ -IN. DISCHARGE, $\frac{3}{4}$ -IN. INLET
(STEAM)
AMERICAN-MARSH
MODEL 202-C-1



WAR DEPARTMENT • 3 APRIL 1944

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Washington 25, D. C., 3 April, 1944

TM 5-2074, Maintenance Manual for Pump, Horizontal, Duplex Piston, Steam Driven, Size 3x2x3-in., 6 GPM, $\frac{3}{4}$ -in. Discharge, $\frac{3}{4}$ -in. Inlet (Steam), American-Marsh, Model 202-C-1, is published for the information and guidance of all concerned.

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By order of the Secretary of War:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

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The Adjutant General.

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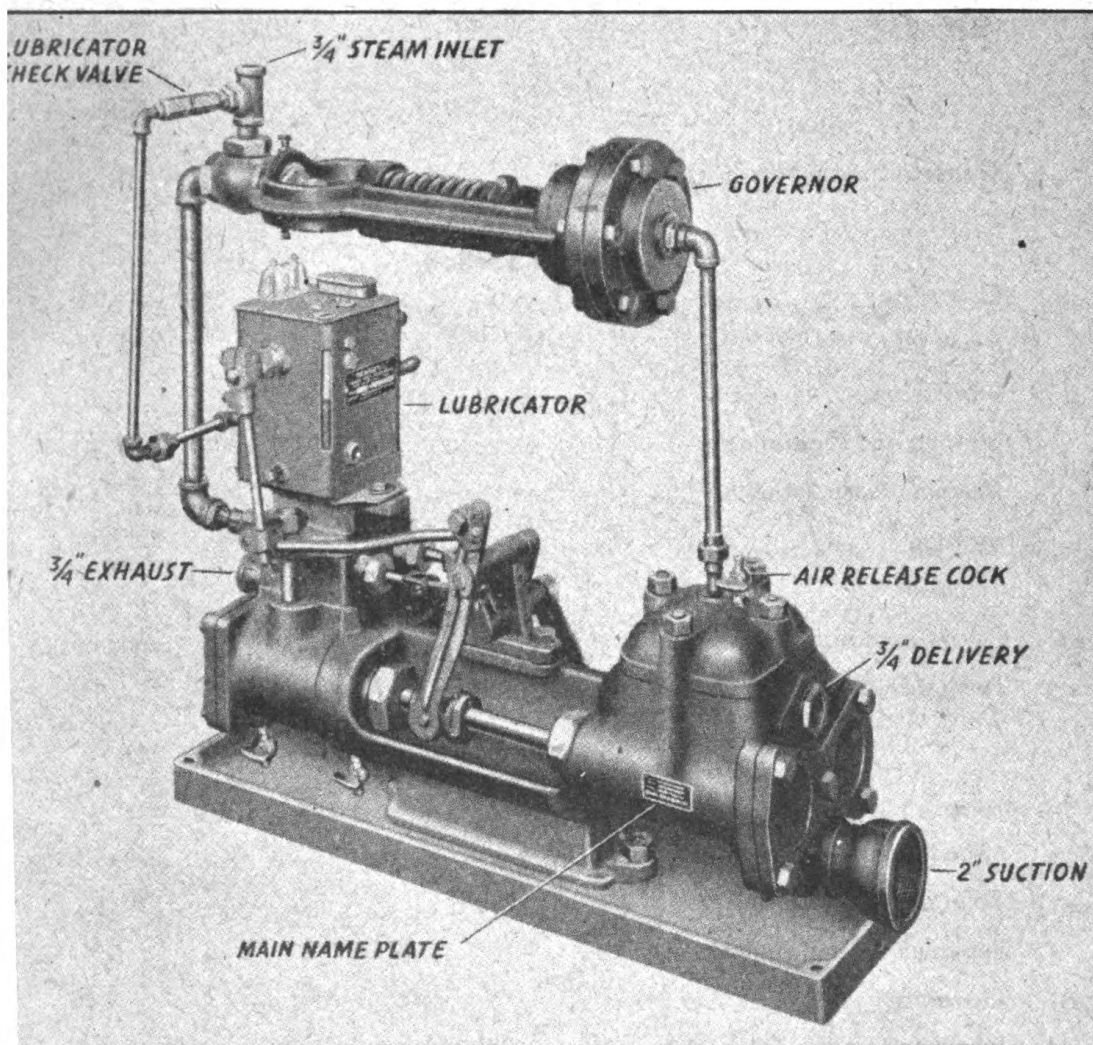


Fig. 1—Complete Unit Assembly

GENERAL DESCRIPTION

1. The **Pump Proper** is a horizontal, duplex piston, steam driven, reciprocating pump for boiler feed service. Detailed information regarding its purpose and operation will be given on page 4.
2. The **Mechanical Lubricator** is as shown in figure 1. Lubricator is of the mechanical piston type and is adjusted in relation to the stroke of the pump so that sufficient lubrication is forced into the governor and down to the steam valve, piston and other internal parts.
3. The **Governor** is as shown in figure 1. Its purpose is to maintain the discharge pressure on the fluid end by automatically regulating the steam pressure admitted to the steam cylinder.

DATA

Performance:

Rated Capacity	6 gallons per minute
Maximum Capacity	9.14 gallons per minute
Rated Discharge Pressure	112 pounds
Maximum Discharge Pressure	250 pounds
Rated Steam Pressure	100 pounds
Maximum Steam Pressure	250 pounds
Rated Piston Speed	80 strokes per minute
Maximum Piston Speed	112 strokes per minute

Note: See page 5 for additional data on operating characteristics.

Weight:

Complete unit, net, unboxed	175 pounds
Lubricator only	12 pounds
Pump only	130 pounds
Governor only	33 pounds

Overall Dimensions:

Length, complete unit	29½ inches
Width, " "	8 inches
Height, " "	26½ inches

Nameplate, (fig. 2), is the unit nameplate and all requests for spare parts should show the serial number and pump size as stamped on this nameplate.

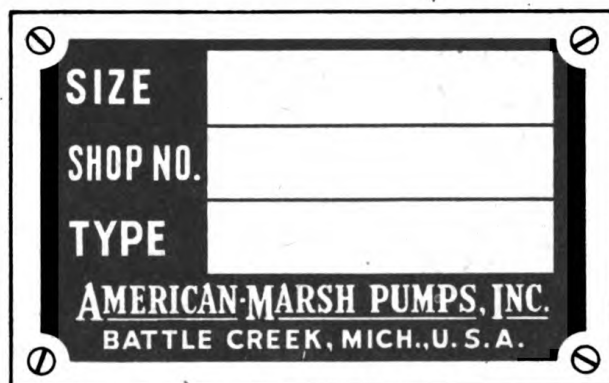


Fig. 2—Main Nameplate

Unit nameplate is located on the right-hand side of the fluid cylinder, as viewed when facing the steam end, looking toward the fluid cylinder. See fig. 1.

OPERATION SECTION

OPERATION

4. General.

General description of this machine is given on page 1. Its component assemblies and their location in relation to the pump proper are shown in figure 1. General dimensions are shown below (fig. 3).

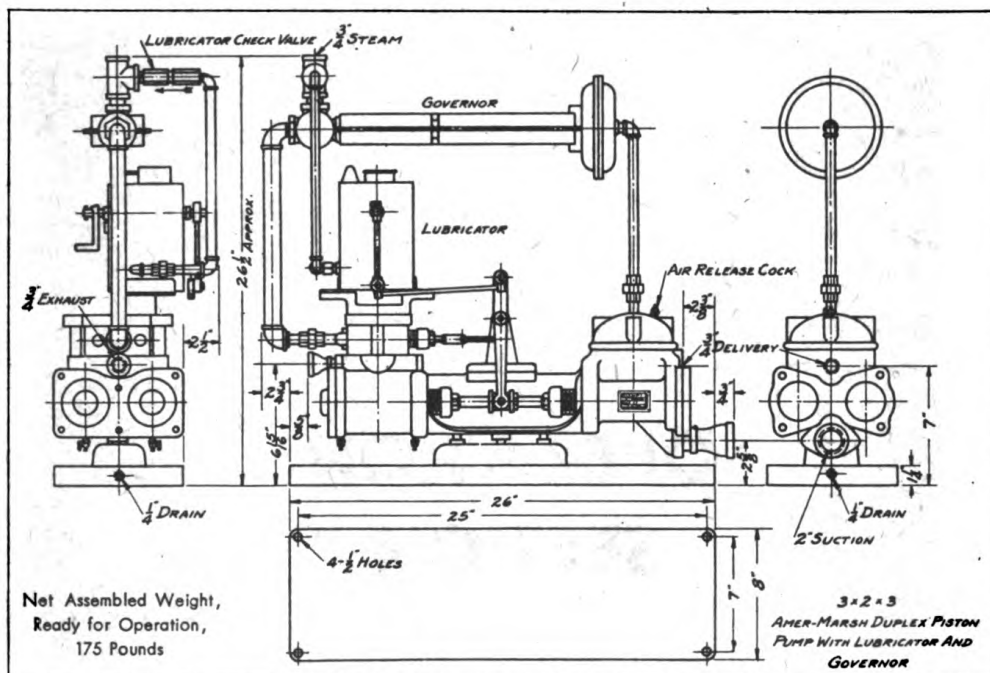


Fig. 3—General Dimensions

The complete unit with its accessories is designated as American-Marsh Size 3x2x3, Model 202-C-1.

The lubricator is of the mechanical type with a self-contained pumping unit, automatically actuated through linkage and levers by the main pump piston rods.

The governor is of the spring loaded type. Its purpose is to automatically regulate the amount of steam admitted to the pump.

5. Principles of Operation.

The pump proper is a horizontal, direct acting, duplex piston, steam driven pump.

It is primarily used in forcing make-up water into boilers against the existing boiler pressure. The first number in the size designation refers to the diameter, in inches, of the steam piston; the second number to the diameter of the fluid piston; and the third number to the length of the stroke.

The pump is of the horizontal type because it is placed in a horizontal position for operation rather than in a vertical position, and the piston rods operate horizontally, or parallel to the ground.

It is direct acting because the fluid cylinder is in a direct line with the steam cylinder and on each piston rod there is a steam piston as well as a fluid piston operating together, independently of any crank movement.

It is of the reciprocating type because it has a to-and-fro motion; moving backward and forward as distinguished from a circular or rotative motion encountered in centrifugal, turbine or rotary pumps.

It is of the piston type because the piston in the fluid cylinder liner that forces the water out and pulls water into the pump is shorter in length than the stroke and requires packing.

It is of the force type because it both lifts water and forces water against pressure greater than that of the surrounding atmosphere. Being a force pump it has both suction and discharge valves and a closed cylinder.

It is of the duplex, double acting type because it is a combination of two complete pumps arranged side-by-side and so connected by linkage that the piston rod of one pump in making its stroke acts through the linkage to move the steam valve to admit steam to the cylinder of the other pump, after which it finishes its own stroke and waits for its own steam valve to be acted upon by a corresponding movement of the pistons of the other side before it can make its own return stroke. In addition, the fluid cylinder is of the double acting type because one end will be filled with water while the other end or other side of the piston is forcing water, previously lifted, into the discharge line.

The pump is normally operated by steam pressure but can be operated by corresponding air pressures and obtain same capacities.

This pump, when properly connected, will lift water from a source of supply as much as 22 feet below the pump location and will discharge this lifted water against as high a pressure as 250 pounds, if sufficient steam pressure is available.

6. Capacity.

This unit is rated to discharge six gallons per minute. It discharges this quantity of water at a piston speed of approximately 80 strokes per minute or a piston travel of 20 feet per minute. This is the maximum recommended operating speed for boiler feed service, handling hot water. If handling cold water, below 100° F., the speed can be increased to 112 strokes per minute.

In calculating capacity on a duplex pump, the strokes per minute are based on the travel of each side so that the capacity determined for a given speed must be multiplied by two to arrive at the actual capacity being discharged by the pump. A stroke, in a double acting pump, is completed when the piston has traveled the full distance of the fluid cylinder. Piston travel is often referred to in feet per minute, that is, a pump with a three inch stroke will travel 20 feet per minute while making 80 strokes.

To calculate the capacity at other speeds or strokes than given above, use the following formula:

$$\text{GPM} = \frac{.7854 \times D^2 \times L \times S}{231}$$

in which

D^2 = square of fluid piston diameter

L = length of stroke in inches

S = number of strokes per minute

Example:—What is the capacity of this unit when operating at 40 strokes per minute?

$$\text{GPM} = \frac{.7854 \times 2^2 \times 3 \times 40}{231}$$

GPM = 1.632 for each side or 3.264 GPM for the total discharge.

The preceding formula does not allow for slip, which is the amount of water that leaks through any clearance between piston packing and valves. On a tightly packed pump, this slip will be negligible but on a unit that is worn it may be as much as 10 per cent of the theoretical capacity obtained by the formula. In addition, one-half the area of the piston rod should be deducted from the cylinder area if an accurate calculation is required, but, here again, the amount of this deduction, on so small a unit as the 3x2x3, has little effect on the final capacity calculation.

7. Pressure.

The discharge pressure against which this unit will deliver water depends entirely on the steam pressure at the pump. The ratio of the area of the steam piston to the fluid piston is multiplied by the pump efficiency and gives the number of pounds water pressure per pound of steam pressure that may be expected from the pump.

On this size unit the ratio is $7.07 \div 3.14$, or 2.25. Pump efficiency varies on different size units from 50 per cent on the size 3x2x3 up to 85 per cent on units having a twenty inch stroke.

Then the ratio 2.25 multiplied by 50 per cent equals 1.12 which means that for each one pound of steam pressure at the pump, the fluid end will discharge against 1.12 pounds pressure. Therefore, if the steam pressure at the pump is 100 pounds, the pump will deliver water against a discharge pressure as great as 112 pounds with a capacity in gallons per minute depending on the number of strokes.

Detailed operating data on the governor and lubricator will be given on pages 14 and 15.

INSTALLATION

8. General.

As much care as possible should be taken in the installation of this unit. However, in a good many cases, because of local conditions, it will be necessary for individual operators to deviate from the recommended procedure; and while a poor foundation or improper piping might cause vibration which will shorten the life of the unit, it will not materially affect its capacity and working pressure.

The following paragraphs will describe the recommended procedure for installation.

9. Location.

The pump should be located in a light, clean, dry and warm place as close to the source of suction supply as possible. The suction lift, particularly the vertical distance from the pump to the source of supply, should be kept at a minimum to insure full capacity. For the same reason, long pipe lines containing many elbows and fittings should be avoided. The unit should be located so there is sufficient room on both sides and on each end to allow inspection, adjustment and repair.

If you are pumping cold water (70° F.) at sea level, the vertical distance that the pump can set above the surface of the supply will be 17 to 20 feet, depending upon the length of the suction line; but this distance should be kept as short as possible.

When you are pumping hot water, then it may be necessary to so locate the pump that the water will flow to the pump suction inlet by gravity. Water boils at approximately 210° F. under atmospheric pressure; but if the atmospheric pressure is reduced by a vacuum being created such as on a suction lift, the boiling point of the water drops below 210° F., so that too high a suction lift may lower the boiling point sufficiently to cause the water to flash into steam and the pump will become steam bound and cease to discharge.

By referring to the following table, you can determine the maximum allowable distance of the pump above its source of supply when pumping cold water and the minimum distance of the pump below its source of supply when handling hot water. The figures preceded by the "minus" (—) sign indicate suction lift in feet, while the values preceded by the "plus" (+) sign indicate the distance the pump must be located below the source of supply.

Practical or Permissible Lifts
For various temperatures and altitudes

ALTITUDE	Temperature of Water in Degrees F.								
	60	80	100	120	140	160	180	200	210
At sea level.....	—22	—17	—13	—8	—4	0	+5	+10	+12
At 2000 alt.....	—19	—15	—11	—6	—2	+3	+7	+12	+15
At 6000 alt.....	—15	—11	—6	—2	+3	+7	+12	+16	
At 10000 alt.....	—11	—7	—2	+2	+7	+11	+16		

10. Foundation.

Having determined the exact location of the pump, the next thing to consider is its foundation. For this particular unit an ordinary wooden floor is suffi-

cient foundation, and the base can be bolted to the floor through the holes provided in the base. As an alternate the base can be bolted to a heavy plank.

11. Suction Pipe.

In laying the suction pipe for suction lift, be sure that the horizontal run from the source of supply to the pump has an upward grade so as to eliminate air pockets. If the source of supply is above the pump level, then the horizontal run should slope toward the pump. Be very careful in laying suction pipe to prevent foreign matter, such as sand, chips from thread cuttings, etc., from entering the line and eventually reaching the pump cylinder as such material could cause serious damage. Make sure that all suction pipe joints are tight and if pipe unions are used they should preferably be of the ground joint type rather than the gasket type.

If operating on suction lift, a check valve or foot valve, if available, can be attached to the end of the suction line immersed in the suction supply, and this will allow the pump to prime faster, but this valve is not necessary, nor should it be installed if suction supply is above the pump inlet.

No other valves are to be installed in suction line if pump is operating on suction lift. If suction under gravity head, that is, if supply flows to pump, install a gate valve in suction line.

12. Discharge Pipe.

The discharge line should be run from the pump to the desired point of discharge, and this line should be kept free from dirt. It is advisable to install both a check valve and a gate valve in this line close to the pump. The purpose of the check valve is to prevent a back rush or surge of water to the pump cylinder after it has been shut down, which back rush could be of sufficient pressure to cause breakage. The gate valve, while not absolutely necessary, can be installed between the check valve and the point of final discharge. Then, if it should become necessary to repair the check valve or the fluid end of the pump, the gate valve can be closed to prevent water running back from the boiler or other points of discharge into the pump.

13. Steam Pipe.

Steam inlet pipe should first be thoroughly flushed before connecting to the tee at the governor body. A globe or gate valve must be installed in the steam line, as close as possible to the pump governor, for manual throttling. It will not be necessary to run any piping from the steam exhaust as the unit can exhaust to atmosphere. However, the exhaust steam is usable and can be piped into a steam heating system, or, for example, into a steel drum containing water and the exhaust steam will materially increase the temperature of the water.

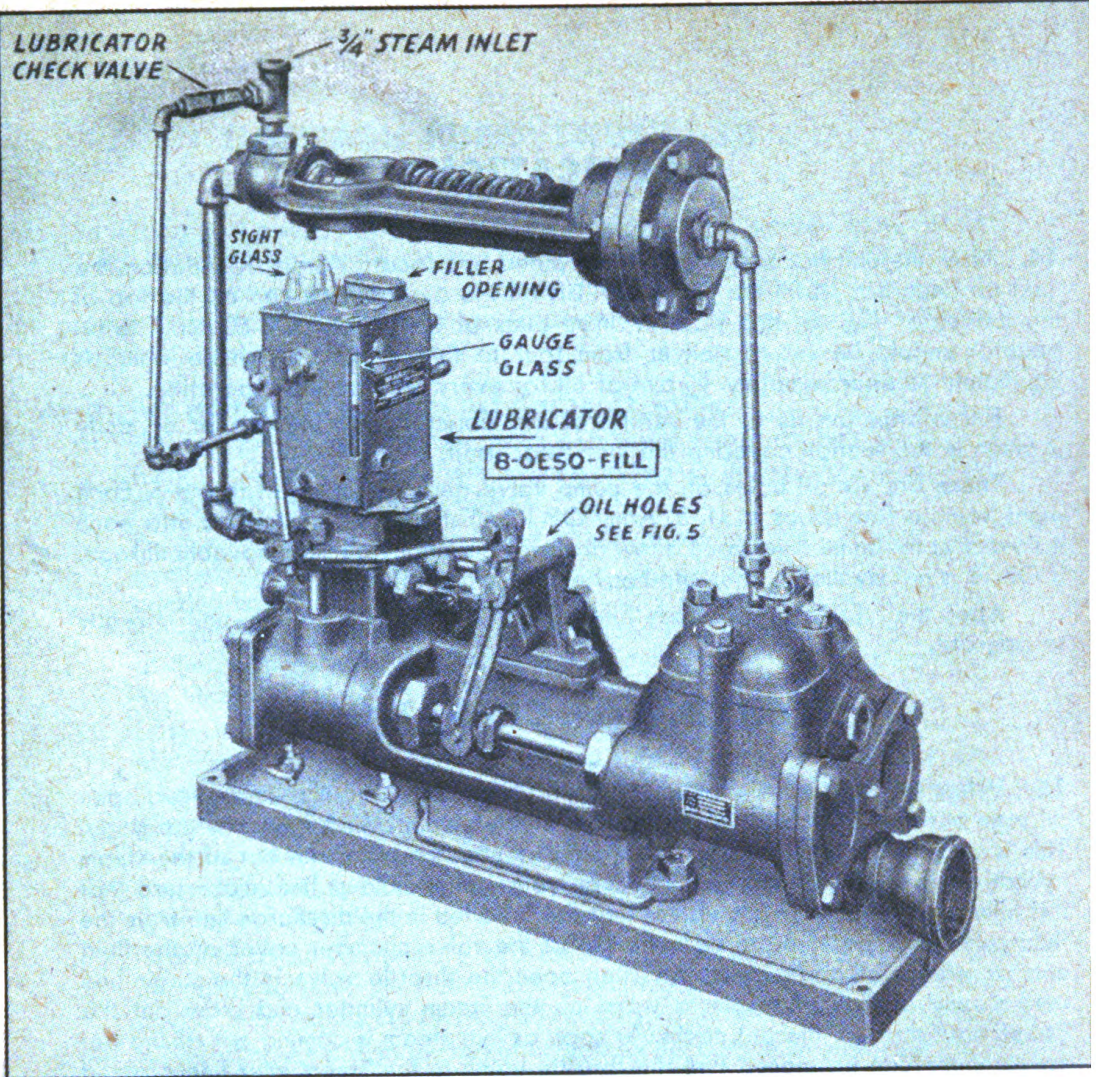


Fig. 4—Lubricator Details

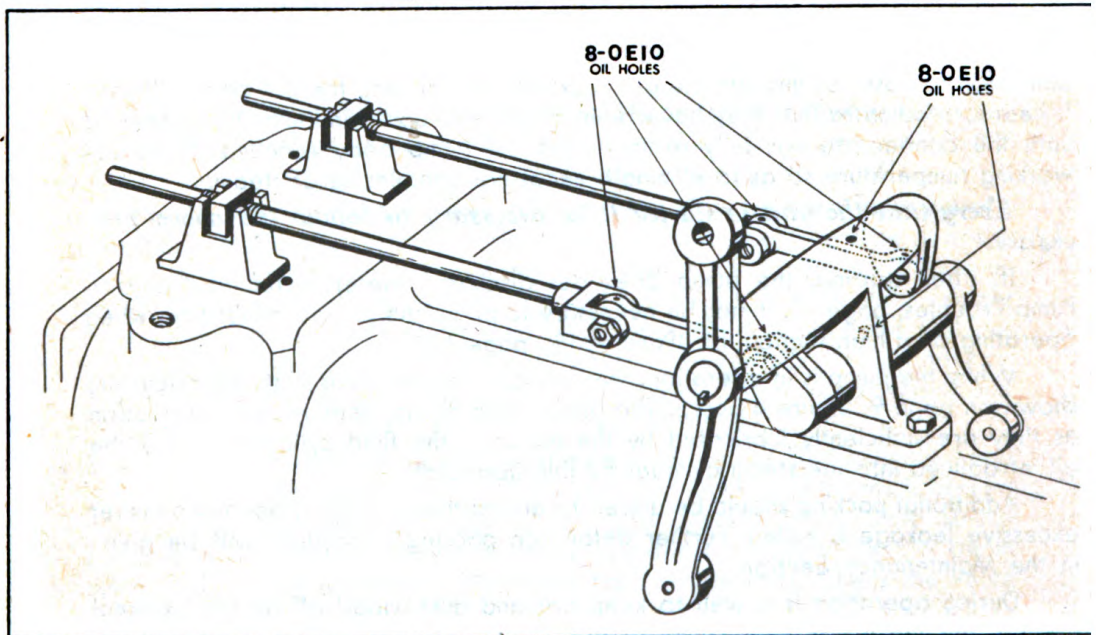


Fig. 5—Oil Hole Locations on Valve Gear

LUBRICATION

14. After the unit has been completely piped and located on its foundation, the next procedure is to fill the lubricator. Lift off the oval-shaped cap on the top of the lubricator (fig. 4), and pour in three pints of U. S. Army OE-50 oil. The lubricator should be set to deliver from four to five drops per minute which is equivalent to approximately $\frac{1}{2}$ pint of oil for every ten hours of operation.

Full information as to the setting of the lubricator for the proper capacity is given in the section covering the lubricator itself, (page 17).

There are six oil holes on the pump valve gear as shown in figure 5. Each eight hours a few drops of U. S. Army OE-10 oil should be introduced into each hole and at the same time place a few drops of oil on any outside movable linkage. If OE-10 is not available, then the heavier grades can be used.

After the lubricator has been filled and the linkage oiled, the unit is ready to operate.

STARTING and OPERATING

15. When starting the unit, either for the first time or at any time thereafter, open all four pet cocks, located in the bottom of the steam cylinder end of the body. This is very important because it allows the condensate to drain out of the steam cylinder. If a valve has been installed on your steam exhaust line, make sure that it is fully open, and open any valves that are installed in the discharge line from the fluid cylinder. Open the pet cock on top of the valve chamber cover on the fluid end to release any entrapped air. Then open the throttle valve in the steam line very slowly and allow steam to warm up the steam cylinder and blow out the condensate through the pet cocks. As soon as live steam is coming out of the pet cocks, these can be closed and the throttle valve in the steam inlet line opened wide and the pet cock closed in the valve chamber cover. If during the progressive opening of the throttle valve and before the steam pet cocks are closed a knock is heard at the end of each stroke, this indicates excessive condensation, and the throttle should be gradually closed until the knocking ceases to allow the condensation to pass out through the pet cocks. If after closing the pet cocks a knock is heard, it indicates that they have been closed too soon and must be reopened until the condensate has fully drained and the pump body reached its normal working temperature so as to eliminate excessive condensing of steam.

Every time the unit is started it is necessary to follow the above procedure.

If, after starting, the pump does not discharge water, refer to Common Pump Troubles, page 11. It may be necessary to prime the pump the first time when operating on a high suction lift, (Para. A (6), page 11).

While the pump is in operation, the only care necessary is that of lubrication, shown on page 9, figure 4 and 5. The piston rods do not require any lubrication as they are sufficiently lubricated by the water in the fluid cylinder and by the oil introduced into the steam cylinder by the lubricator.

Additional packing should be added to any of the six stuffing boxes whenever excessive leakage is noted. Further details on packing procedure will be given in the Maintenance Section.

During operation it is well to keep grit and dust wiped off all the external linkage and the piston rods so as to prevent this abrasive material from going into the pump and causing wear.

COMMON PUMP TROUBLES

16. On this type of pump, 90 per cent of the trouble will be caused by air in the suction line or by defective fluid piston packing. Outlined below will be several points for the operator to check in case the pump is not working properly. For the proper correction of some of these troubles, it will be necessary, however, to refer to the Maintenance Section.

A. If after starting, pump does not discharge water:

- (1) Examine suction pipe for air leaks and see if there are any pockets in suction line: that is, are there any points higher in the suction line than the suction opening in the pump?
- (2) Remove fluid cylinder head and check piston packing. It may have swelled, and if too tight, loosen it by slicing off part of a ring or if the packing has been in the pump for some time, install new packing. When installing new packing, slice off the second ring so that the total width of the packing is about 1/8-inch less than the actual packing space on the head to leave an allowance for swelling.
- (3) Examine the fluid valves and see if they are obstructed by sticks, waste, etc., check for partly closed or broken valves in the discharge line, and if used for boiler feeding, examine check valve to see if it is opening. Also look for lime deposits in discharge line to boiler if piping has been in service for a considerable period of time.
- (4) If there is a screen or strainer on the end of the suction line, is it clogged with leaves, dirt, etc.?
- (5) Examine piston rod packing and renew if necessary. It should never be necessary to have the stuffing box gland nut drawn up so tight that the piston rod is dry as the rod should be moist at all times during operation.
- (6) If operating on a high suction lift it may be necessary, when first starting, to manually prime the pump by filling the valve chamber on the pump with water. Water can be poured in by removing the pet cock on the chamber.

B. If the pistons move but the pump will not lift water, check the points given in Paragraph A.

C. If the pump will not take water promptly without priming, check for excessive air leakage at piston rod stuffing box, and look for air leaks in the suction line. Also check items covered by Paragraph A, (1) (3) (6).

D. If pump operates and takes water then slows down and barely moves, look for obstructions in discharge line; also check for lime deposits as well as other items as covered by Paragraph A, (3). Check for broken or partly closed valves in steam inlet line and make sure that the steam supply through the governor is not clogged. Remove steam cylinder head and see if the gasket is broken allowing steam to blow through from one cylinder to the other. If pumping hot water, fluid piston packing may have expanded and is binding on cylinders as covered by Paragraph A (2).

E. If piston stops at the end of the stroke, remove the fluid cylinder head and see if the water piston follower is in place. It may have become loosened and is working partly or wholly off the rod preventing complete stroke because of the piston striking the fluid cylinder head. Examine the steam cylinders to see if the steam pistons are tight on the rods. Check the valve setting as outlined on Page 25.

F. Miscellaneous — If the pump should not start after steam is applied, all steam line valves should be checked, after which, check to see if the steam piston may be loose on the rod or frozen to the cylinder. Also check to see if the main steam valves in the steam chest have over-ridden their ports and are frozen to the chest. Jerky operation in starting indicates failure of the water supply to follow the water piston. This trouble may be due to an obstruction in the suction line.

If the pump becomes vapor-bound it can be freed by turning cold water on to the fluid end. If the pump should race without any increase in capacity, this indicates faulty piston packing or fluid valve or valves stuck in the open position.

Groaning in the fluid end usually indicates tight fluid piston packing, while groaning in the steam end indicates lack of lubrication.

STORAGE

17. Limited Storage.

If it should become necessary to store the unit, it should first be thoroughly drained by opening the pet cocks underneath the steam cylinders and removing the four drain plugs underneath the fluid cylinder and opening the pet cock in the valve chamber cover of the pump. Break the steam inlet line ahead of the governor and pour in the steam inlet line to the pump about one pint of OE-50 oil. Reconnect the steam line and run the pump for a half-dozen strokes so as to distribute the oil over the inside of the steam end. Then disconnect the steam line and break the three pipe unions so that the governor and its piping can be lifted off as an assembly. The lubricator can be removed or left on depending on individual conditions. All openings should now be closed and the larger pipe openings plugged to prevent dirt from entering the internal part of the pump. All exposed rods and linkage should be covered with a heavy grease to prevent corrosion.

18. Dead Storage.

Refer to TM-5-9715 Technical Manual, Preparation of Corps of Engineers Equipment for Storage, issued November, 1943. This was issued by the Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

SHIPMENT

19. Shipment by troop organization for short distances, either by rail or truck, will not require elaborate packing. The procedure given for limited storage should be followed, and the governor should be removed so as to prevent pipe breakage in transit. Other than this, the unit will not require any protection above that to withstand the transportation.

20. For export shipment, refer to TM-5-9711 Technical Manual, Preparation of Corps of Engineers Equipment for Export, issued October, 1943. This was issued by the Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

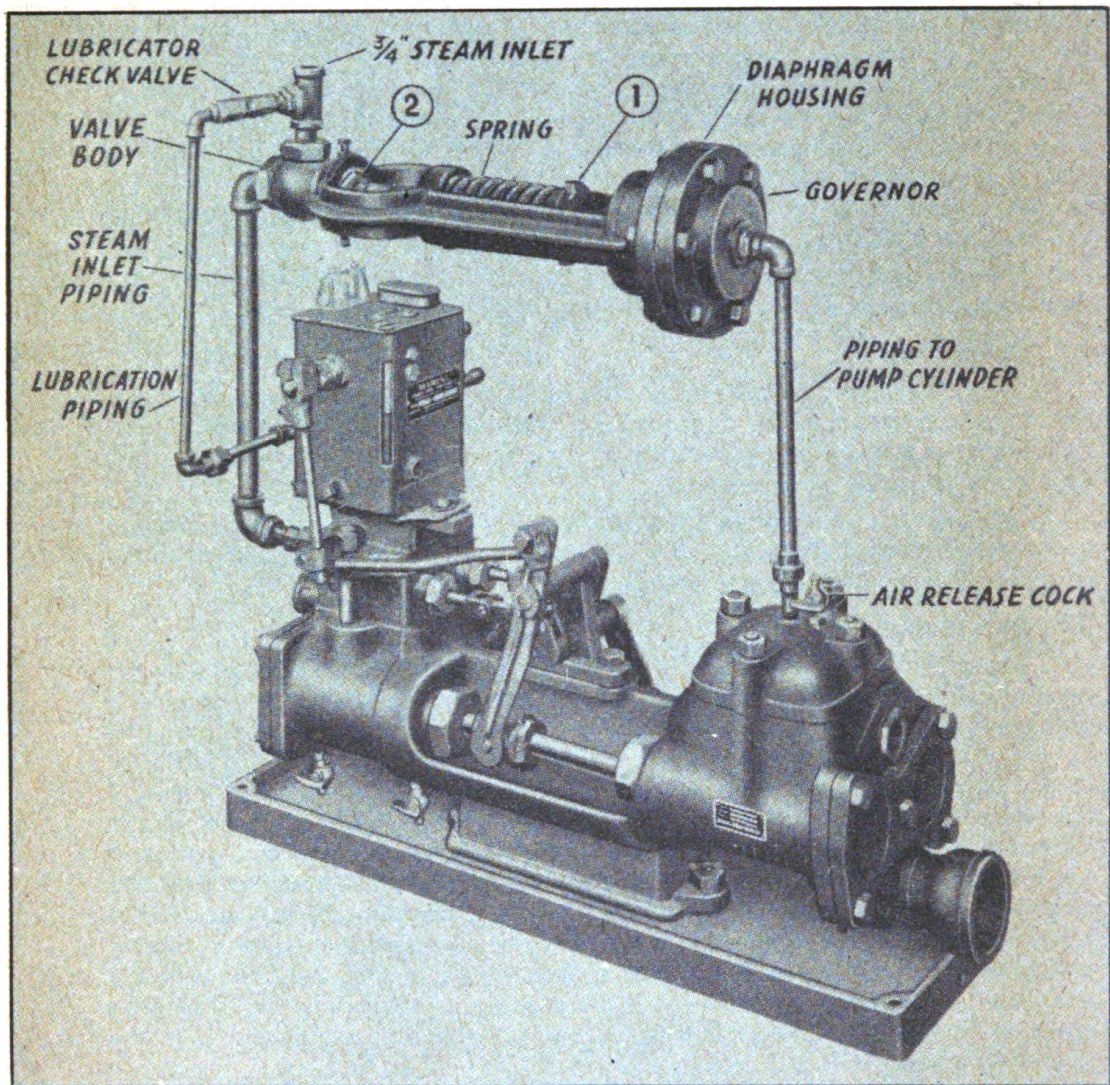


Fig. 6—Governor Details

PUMP GOVERNOR

21. General

The purpose of the pump governor is to throttle the steam inlet so as to maintain a constant discharge pressure. The diaphragm end of the governor is connected by piping to the top of the pump cylinder as shown in fig. 6. As the discharge pressure rises, the diaphragm in the governor is forced toward the steam end of the pump and the valve, in the governor body, starts to close and throttle the amount of incoming steam. This throttling prevents additional pressure from being built-up in the pump fluid cylinder. This means that the pump will not work against a higher pressure than that for which the governor has been set and, if it is desired to operate against a higher discharge pressure than 112 pounds, for which the governor has been originally set, it will be necessary to increase the governor spring tension, as outlined below.

The governor is a Model 180, $\frac{1}{2}$ inch size, manufactured by the Davis Regulator Company. The installation of the governor is shown on page 13, (fig. 6).

22. Operation.

The governor will require very little attention. It is lubricated by the pump lubricator because all of the oil forced into the steam line by the pump lubricator must first pass through the valve body of the governor and the valve body is the only point requiring lubrication.

Exposed rods on the governor should be kept clean. If there is steam leakage at the governor stuffing box (2, fig. 6), a small amount of packing should be added as outlined in the Maintenance section.

23. Adjustment.

The governor, as furnished, is set for operating at 112 pounds discharge pressure with 100 pounds steam pressure. If the actual discharge pressure is greater or less than 112 pounds or the steam pressure greater or less than 100 pounds it will be necessary to adjust the tension on the spring. This is done by turning the adjuster (1, fig. 6) to increase or decrease the spring tension. Increasing the tension on the spring by turning the adjuster toward the valve body allows the pump to work against higher than 112 pounds discharge pressure. Decreasing the tension by turning the adjuster toward the diaphragm allows the pump to operate against discharge pressures less than 112 pounds. There is no definite way to determine the exact number of turns on the adjuster to give a definite operating pressure—you will have to loosen or tighten the adjuster until the desired operating range is reached. In the absence of steam inlet and discharge pressure gauges, the only indication of correct governor adjustment is in the operating speed.

PUMP LUBRICATOR

24. General.

The purpose of the lubricator is to automatically supply sufficient oil to the pump governor valve, steam chest slide valves, steam pistons and cylinders.

Lubricator is a Manzel Model XD-902-L, 3-pint capacity, as manufactured by the Manzel Brothers Company.

The lubricator should be kept filled with U. S. Army OE-50 oil, and if properly set it will use three pints every 60 hours of operation.

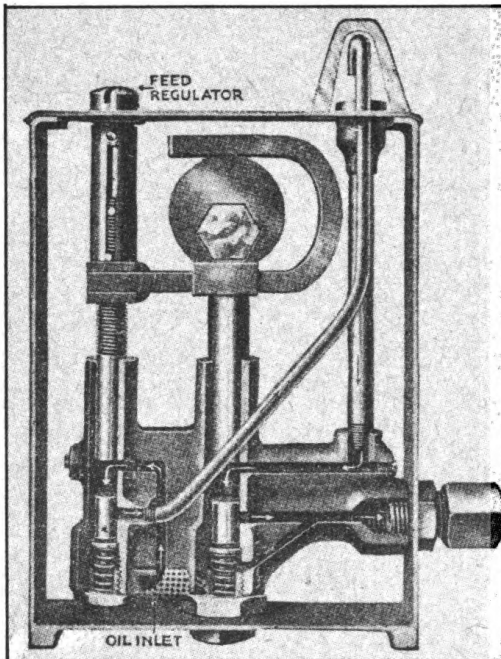


Fig. 7—Cross Section of Pumping Unit, Showing Oil Flow.

Operation.

Lubricator has a pumping unit as shown in fig. 7, operated by an eccentric placed on the hexagon shaft. The pumping unit is actually a small double plunger pump. Under the plunger there is a small piston valve. On the upward stroke of the smaller plunger the oil is drawn into the pumping unit through the oil inlet. On the downward stroke the plunger forces the piston valve down, opens the outlet port and forces the oil through the small tube to the sight glass where it drops into the oil cup below. As the plunger travels upward again, the piston valve automatically closes the port. The larger plunger operates in the same way, excepting that it draws the oil from the oil cup under the drip tube and forces it to the steam inlet.

25. Installation. (See fig. 8).

Lubricator is mounted on steam chest cover of the pump, being attached to a U-shaped bracket by capscrews. The lubricator is set on this bracket so that the shaft extension through the side opposite the lubricator crank is on the same side of the pump as the pump nameplate.

With the drive rod (1) in a vertical position and the connection (2) on the pump long lever in a vertical position, attach lubricator arm (3). Tighten connection set screws (4) on both the pump lever and the lubricator drive rod. Make sure that the check valve has been installed in the pipe line from the lubricator to the tee at the governor and check to see that the arrow stamped on the check valve is pointing toward the steam line and away from the lubricator. Check to see that when the pipe line is tight, the cupped part of the check valve needle is in a downward position. It will be noted that there is a slot in this cup portion, the purpose of which is to break the oil into a mist when the drop of oil comes into the cup and steam pressure is on the line.

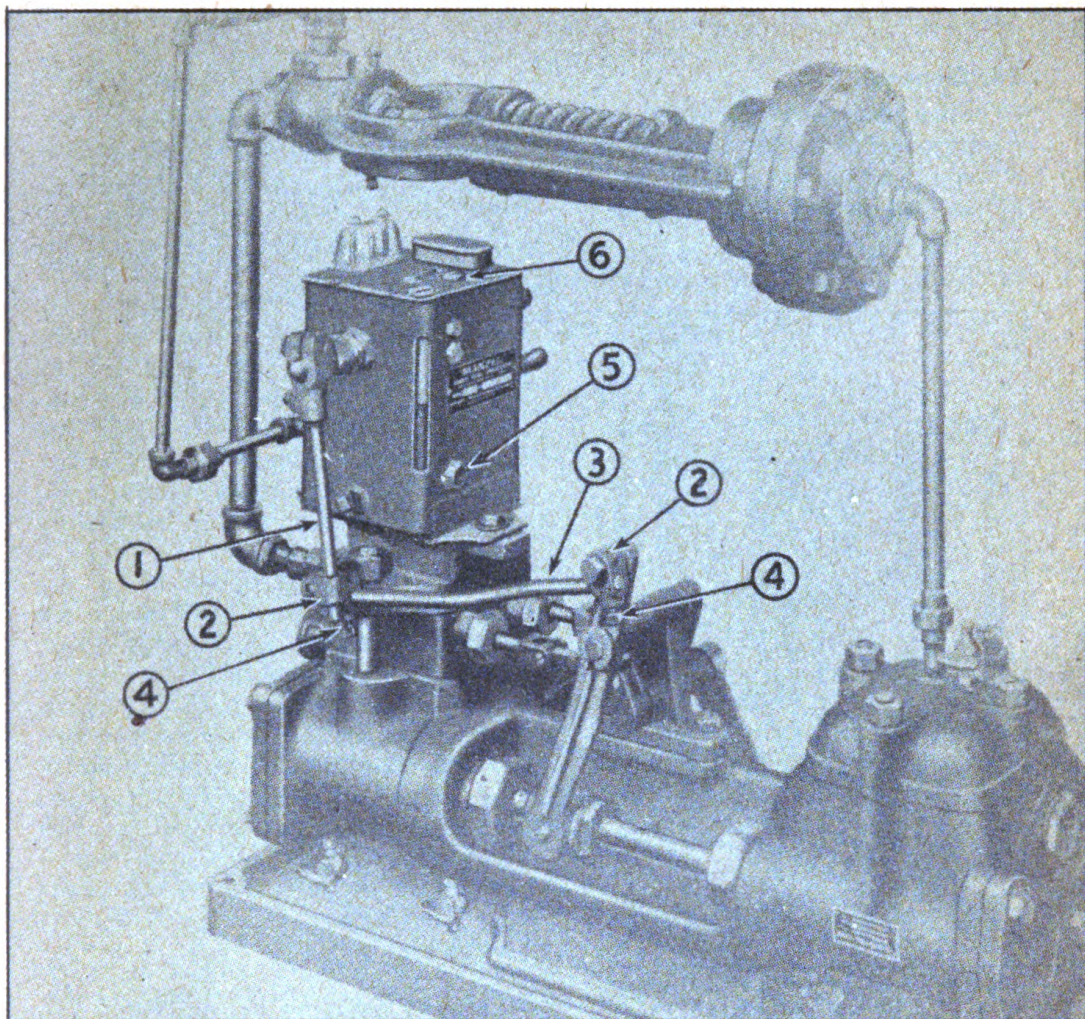


Fig. 8—Attaching the Lubricator Connections

As soon as the lubricator has been installed, pour in three pints of oil and make several turns of the hand crank to make sure that oil is started in the oil line before the steam pump itself is actually placed in operation.

The use of the hand crank will not affect feed regulation and is sometimes used for momentarily increasing the amount of oil supplied to the steam pump while the pump is in operation and in filling the oil line before starting after disassembly.

26. Heating Chamber. (See fig. 8).

The lubricator, when used for outdoor work, may require the heating chamber connection for warming the oil in extremely cold weather. The heating chamber connection (5) is located near the bottom of the lubricator and extends through the reservoir. To connect the heating chamber, run a $\frac{1}{4}$ -inch pipe from a tee placed in the steam exhaust line from the pump proper and connect this line to either side of the heating chamber connections. From the side opposite that connected, run a $\frac{1}{4}$ -inch pipe toward the ground to carry off the exhaust steam and prevent burns to the operator.

Do not plug up one side of the heating chamber, but allow the steam to blow through. If desired, a globe valve can be placed in the pipe line from the steam exhaust to the heating chamber so that the operator can turn off the heating chamber line when it is not required.

27. Adjustment. (See fig. 8).

It may be found necessary to increase or decrease the amount of oil supplied by the lubricator. The feed of the lubricator is regulated independently and can be adjusted while pump is in operation. The capacity of this lubricator is a minimum of one drop of oil every three strokes of the arm (1), and a maximum of 12 drops with each stroke of the arm.

To increase the feed, place a screw driver in the slot of the feed regulator (6) and turn to the left or in the direction shown on the small nameplate near this screw. Observe the number of drops per stroke or strokes appearing in the sight glass and continue to turn until the desired amount is being supplied.

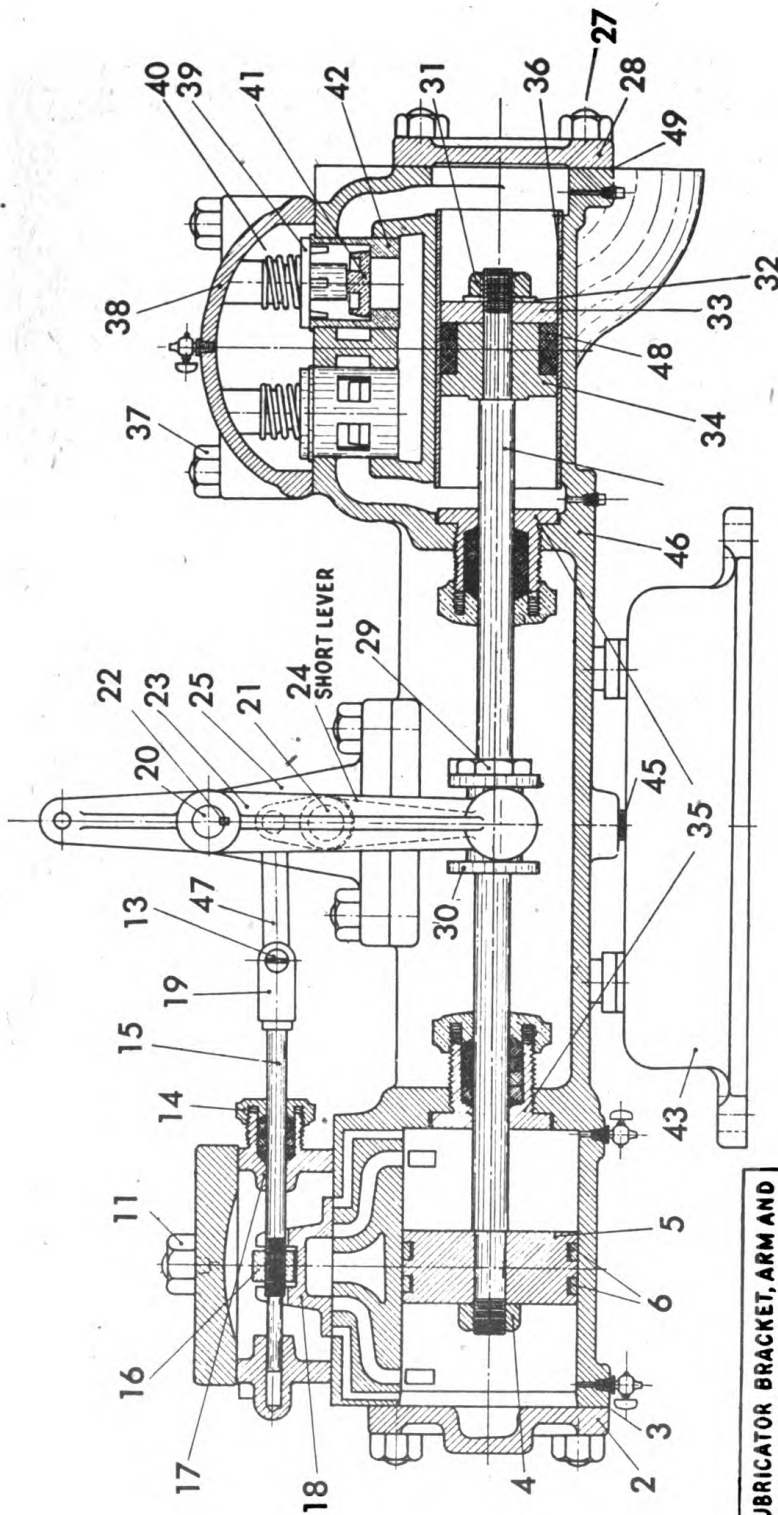
To decrease the feed, turn the feed regulator (6) to the right or in the direction shown on the plate and observe the quantity appearing in the sight glass.

Approximately 12 complete turns of the feed regulator screw are required to adjust from minimum to maximum feed.

If the lubricator is set to deliver more than five drops of oil per minute it will not harm the unit but will waste valuable oil.

There is a lock spring underneath the feed regulator which holds it rigidly in place after each adjustment.

MAINTENANCE SECTION



LUBRICATOR BRACKET, ARM AND CONNECTION ARE NOT SHOWN SEE FIGURE 10

Fig. 9—Sectional View, Main Pump Assembly

MAINTENANCE

PUMP

28. General.

The sectional print (fig. 9) shows the various pump parts in relation to each other, and the exploded view (fig. 10) shows the parts in disassembled position.

Part numbers mentioned in the Pump Maintenance instructions apply to either figure as part numbers in fig. 9 correspond to the same part number for the same piece in fig. 10, but some part numbers mentioned do not appear in fig. 9.

Fig. 11 shows the piping arrangement and the tools furnished with the unit.

Maintenance on the pump proper will consist mainly of packing replacement and the occasional grinding of fluid valves. Before doing any work, it is suggested that the entire section on Maintenance be read so as to eliminate unnecessary dismantling.

29. Steam End Disassembly.

Break the pipe union in the steam inlet line and remove the six capscrews (1) holding steam cylinder head (2). Remove cylinder head, and if it is tight it can be loosened by lightly tapping the edges with a hammer, using care to prevent damage to the gasket (3). Using wrench (4, fig. 11) on the hexagon part of the piston rod spool (30) to hold it, remove steam piston rod nuts (4), using wrench (3, fig. 11). Screw the puller bolt (1, fig. 11) into the tapped hole provided on each steam piston (5) and withdraw pistons. Remove piston rings (6) from the pistons and clean piston and rings in fuel oil or solvent.

Break the pipe union in the lubricator pipe line. Mark lubricator arm (7) with a file at its present location in the two lubricator connections (2, fig. 8) so that it can be replaced in the same position as it was removed and not affect the lubricator pumping capacity. Loosen the lubricator connection set screw (8) and remove the lubricator arm, after it has been marked. Remove the two capscrews (9) holding the lubricator to the bracket (10). Remove the lubricator, but leave the bracket attached to the steam chest cover. Remove the two steam chest nuts (11) and lift off steam chest cover (12), taking care not to damage gasket. Remove coupling pins (13) and loosen gland nuts (14). Pull the valve rods (15) out of the steam chest, unscrewing valve rod nuts (16) as the rod is pulled out. This leaves the steam chest proper (17), lower chest gasket and the slide valve (18) free for removal.

30. Valve Gear Disassembly.

Remove coupling pins as described above, both at the coupling (19) and at the rockershafts (20 and 21). Remove lubricator connection screw. Pull gib keys (22) from both rockershafts. This allows both the long and short levers (23 and 24) as well as the rockershafts to be removed from the cross stand (25). Remove the two capscrews (26) holding the cross stand to the pump body to release the cross stand.

31. Fluid End Disassembly.

Break pipe union in governor pipe line to valve chamber. Remove the five capscrews (27) holding fluid cylinder head (28) and remove head, by tapping around the edge with a hammer, taking care not to damage the gasket. Using wrench (3, fig. 11), loosen both fluid piston rod nuts (31) and remove them along with the washers (32). (If steam end has not been dismantled, hold spools with

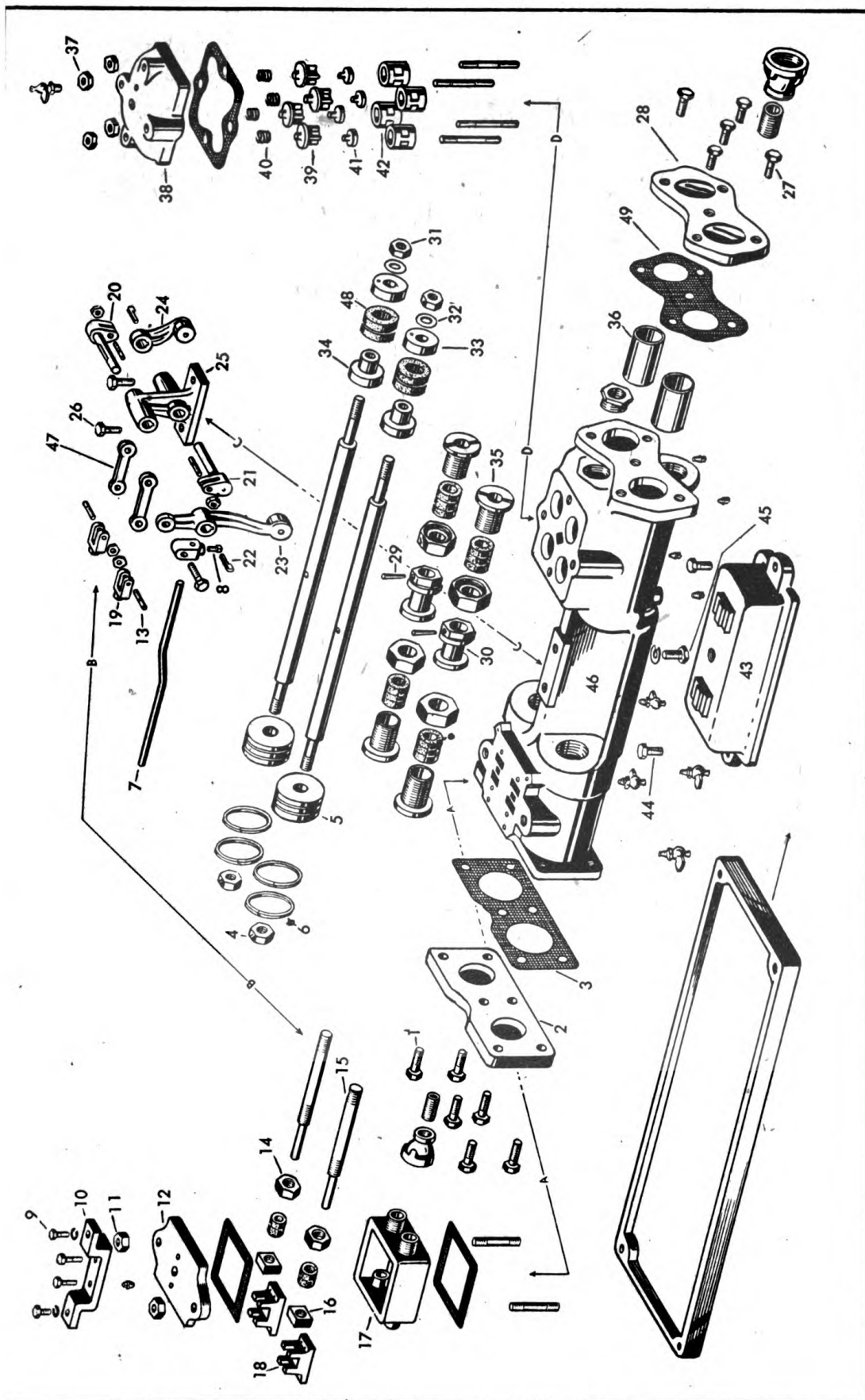


Fig. 10—Exploded View, Main Pump Assembly

wrench (4, fig. 11) as outlined in preceding paragraph). Pull out both taper pins (29) on piston rod spools (30). Screw puller bolt (1, fig. 11) into the tap provided on the followers (33), and withdraw them from the body. (If the steam pistons have already been removed, the rods can be pulled through the fluid end of the body and the fluid piston assembly dismantled after removal.) Screw puller bolt into tap provided in fluid piston (34) and withdraw from cylinder. Remove rod boxes (35) by unscrewing from the body. The only practical way to remove the liners (36) in the field is to cut them out with a cold chisel, and these should never be removed unless it is necessary to make replacement. This also applies to the rod boxes which should never be removed unless they require replacement.

Remove the four nuts (37) on the valve chamber cover (38) and remove cover, taking care not to damage gasket. The discharge valves (39), valve springs (40) and suction valves (41) can be lifted out from the valve seat (42). The valve seats (42) are pressed into the fluid cylinder with a taper fit; and if these are to be removed it may be necessary to cut them out with a chisel, but they should not be removed unless they require replacement. To remove the foot (43), first remove the two capscrews (44) holding the foot to the base and then remove the capscrew (45), the head of which is underneath the foot and holds the foot to the body.

This completes the dismantling of the pump proper.

INSPECTION OF PARTS

32. Due to the design of the pump, the parts will seldom require replacement until completely worn out or broken. Loose valve linkage, even though noisy, does not mean impaired operation on such a small pump. Valves will stand several grindings before requiring replacement.

TOLERANCES

Fluid Pistons.....	1/64 inch on outside diameter.
Fluid Pistons.....	Push fit on rods.
Liners.....	Drive fit in cylinder.
Rod Boxes.....	.020 inch larger than rod.
Spools.....	Light push fit on rods.
Steam Piston.....	1/64 inch on outside diameter.
Steam Piston.....	Push fit on rods.
Gaskets.....	1/16 inch maximum thickness to 1/32 inch minimum.
Piston Ring.....	Free diameter about 3-3/16 inches, compressed diameter is snug fit in cylinder. When compressed should have .008 to .010 inches space between joints.

REPLACEMENT and ADJUSTMENT

33. General.

After the unit has been disassembled, clean all parts with fuel oil or solvent and flush out the pump body (46). Check all steam port openings leading from steam chest to steam cylinder to make sure they are free from oil sludge or other foreign material.

Remove all old packing and clean out packing spaces.

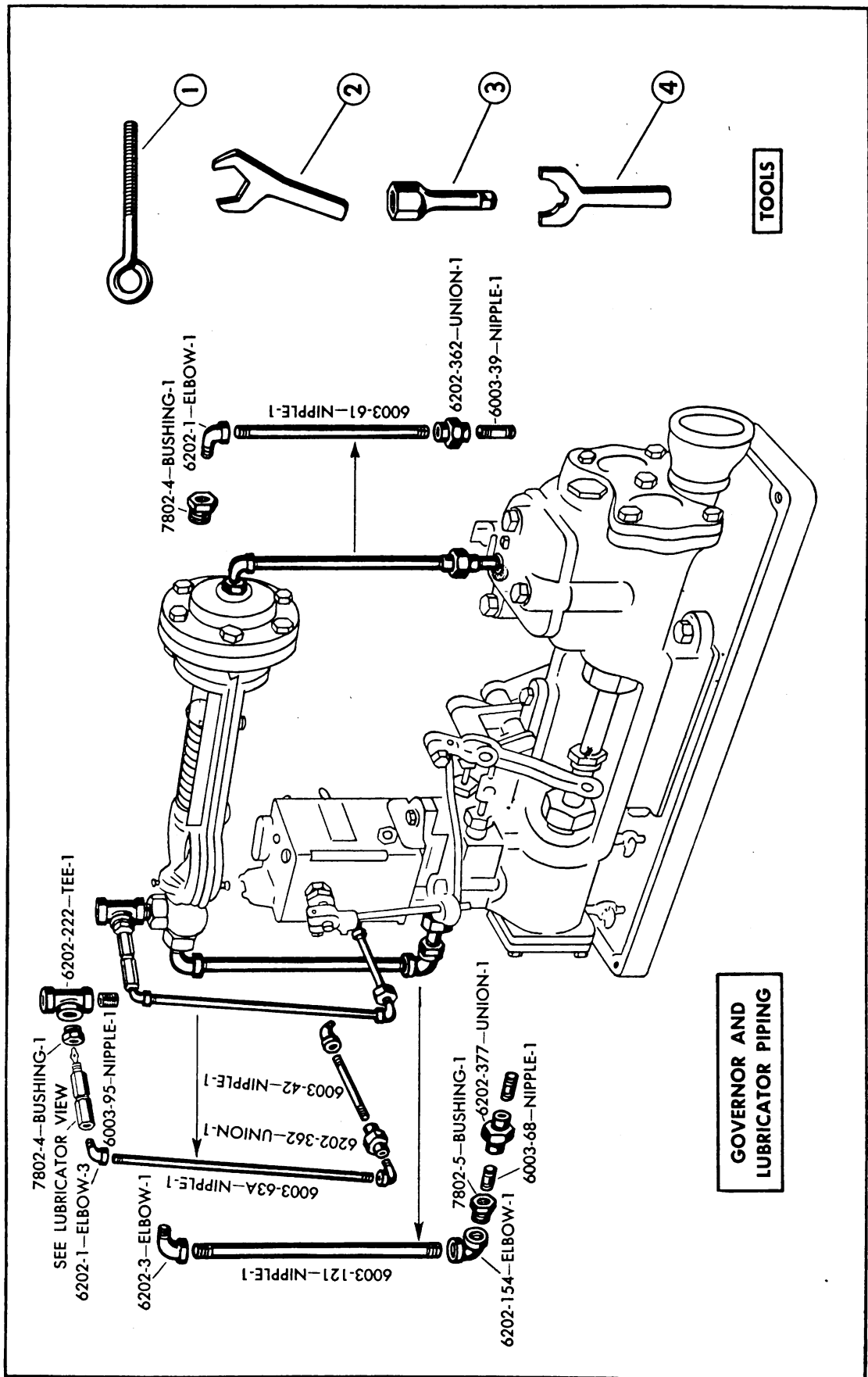


Fig. 11— Piping and Tools

Check all gaskets for breaks before reinstalling and apply shellac, if available, to one side and set in place. On the side next to the removable head, smear OE-50 oil. This allows the gasket to be more permanently located and prevent damage to it when removing parts.

34. Stuffing Boxes.

Smear threads and inside face of flanges with white lead or pipe joint compound before screwing into the body. Make sure that boxes are screwed in tightly and then wipe off any compound remaining on the exposed thread work.

35. Piston Rods.

Insert rod through one cylinder. Then slide on one gland and piston rod spool (30). The spool should be a light push fit on the rod and the hexagon end of the spool should be on the side toward the fluid cylinder. Then push the rod on toward the opposite cylinder and before going through the opposite rod box, slide on the other gland nut in its proper position and push the rod on through into the other cylinder. Insert taper pin (29) in spool and drive it in tightly.

36. Steam Valve Fitting.

If, in replacing the steam slide valve (18), it is found that the steam chest face of the pump body is worn, it is necessary to smooth and true up the face with a file. Wipe off all filings. Smear the face of the pump body around the ports and the slide valve position with grinding compound, the same as used in grinding valves on internal combustion engines. Using a movement in the same direction as the valve operates, with hand pressure, rub the valves on the body until an even seating surface is indicated. This can be determined by inspecting the valve face after rubbing; and if the entire surface of the valve face is bright, the valve is properly seated, but if there are dull spots it will be necessary to again smear with grinding compound and repeat the operation. After the valves have been seated, flush out all filings and grinding compound with solvent, taking particular care that steam port openings are clear. Do no further assembling of the steam chest until the steam pistons are in place.

37. Steam Pistons.

Install both piston rings (6) on to the steam piston (5) and turn the rings on the piston so that the joint or cut portion of one ring is on the opposite side of the piston from the other side. Slide piston on piston rod and the piston should have a light push fit. Compress each ring as piston assembly enters the cylinder and make sure that the piston is flush against the shoulder on the rod. Screw on the steel steam piston nut and draw it up tightly—no washer is required. Attach steam cylinder head (2), making sure that the gasket (3) is in place and in good condition. In drawing up the steam cylinder head capscrews, draw evenly and snug

38. Steam Valve Setting. (See Fig. 12)

If, during operation, the pistons stop at one end of the stroke, it is an indication that the steam slide valves are out of adjustment. Also, whenever the steam chest has been dismantled, the valves must be reset.

The first step in resetting is to locate both steam pistons in the center of their respective cylinders. This can be done by forcing each piston to the back or cylinder head end of the cylinder and mark the rod at the outside edge of the stuffing box to designate this point. Then force each piston to the extreme opposite end of the cylinder on the rod box end and again mark the rod at the edge of the stuffing box. Divide the distance between marks on each rod and mark this point on the rod. Then slide both rods back until the center marks are in line with the outside edges of the stuffing boxes and the pistons are then in the dead center of their respective cylinders. **In marking the rods, use a very light mark to**

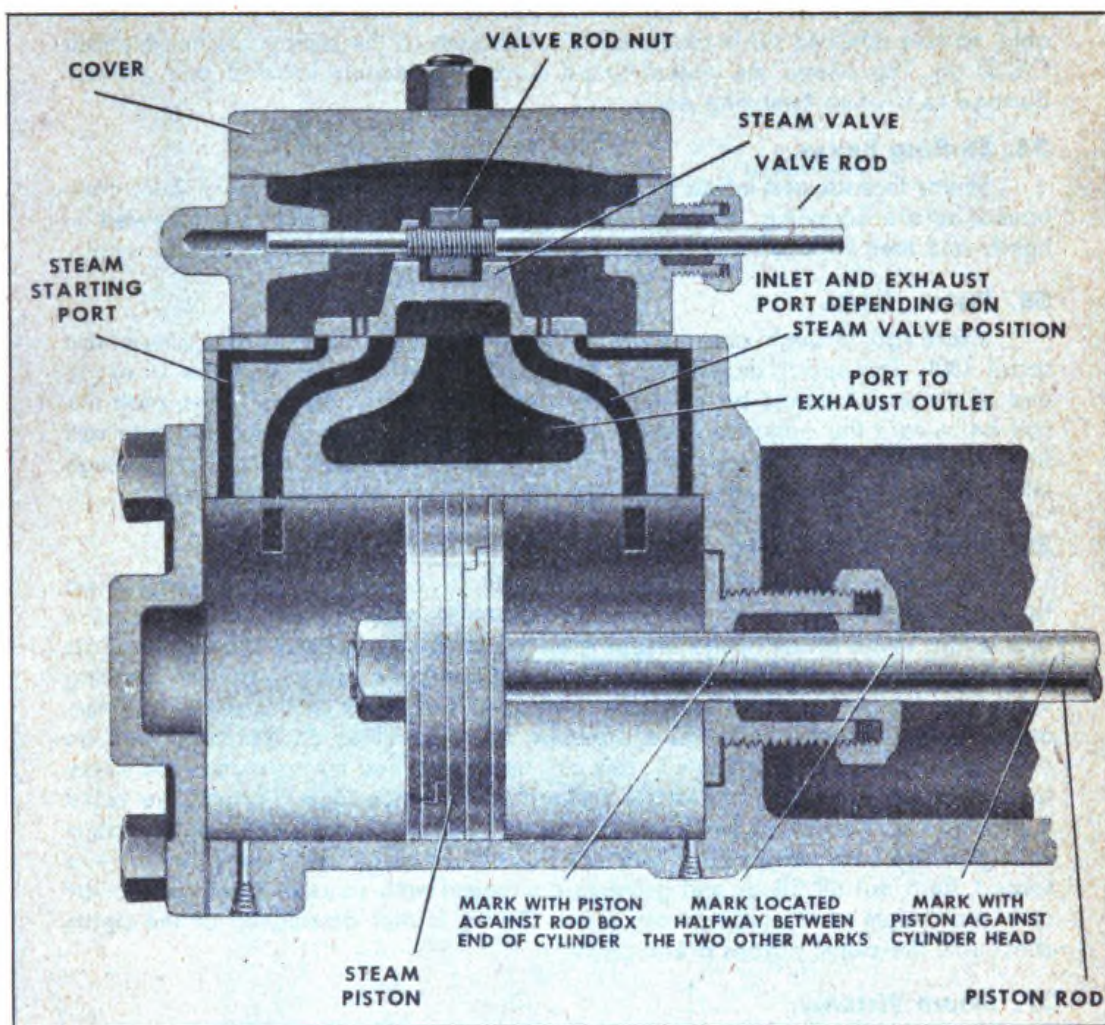


Fig. 12—Location of Steam Piston and Steam Valve at Exact Center

prevent scoring of rod during operation. A very light scratch made with a sharp pointed instrument or tool is preferable. Remove steam chest cover, if in place, and install valve gear as outlined in the following paragraph, if it has been dismantled. With valve gear in place locate the slide valves so that the slide valve openings are in the exact position in relation to the steam cylinder ports as shown in the following illustration.

Be sure that the slide valve nuts (16) are located on the valve rods so that on each valve the distance from one edge of the nut to the slide valve prongs is the same as the distance from the other edge to the valve prongs on that side. This is to give sufficient lost motion.

Correct valve setting is important so that the pump will operate properly at its full stroke and duplex properly—that is, one piston should follow the other, and one side should be in motion as the other side comes to a momentary rest.

39. Valve Motion Assembly.

Clean off all grease with fuel oil or solvent. Unless parts are very badly worn they will not require replacement.

Mount cross stand (25) on pump body. Install rockershafts (20 and 21), dipping each one in OE-10 oil before inserting. The upper rockershaft (20) can be identified by the dimension from the center of the shaft proper to the center of the coupling pin hole of $1\frac{7}{32}$ inches, while on the lower rockershaft (21), the same relative dimension is only $\frac{27}{32}$ inches.

Mount long lever (23) on shaft extension of the upper rockershaft and install gib key (22). Install short lever (24) on shaft extension of lower rockershaft and install gib key, making sure that the round discs attached to the bottom of the levers are engaged in the piston rod spools (30).

Attach lubricator connection to the top of the long lever. Attach links (47) to rockershaft clevis with coupling pins and nuts. Attach couplings (19) to valve rods (15), and screw glands (14) on to stuffing boxes. Insert valve rods through steam chest stuffing boxes and with steam slide valve in place screw valve rod through valve nut. (See Steam Valve Setting, page 25.)

40. Steam Chest Assembly.

After steam valves have been ground in and valve gear assembled, replace top gasket on steam chest. Pour about $\frac{1}{4}$ pint of OE-50 oil into steam chest for initial lubrication of chest and cylinders. Replace steam chest cover and mount lubricator on bracket. Connect lubricator arm (7) to connection on long lever, extending arm through connection to previously made mark and tighten connection set screw (8).

41. Fluid End Assembly.

Be sure fluid end is clean—free from sticks, leaves, etc. When inserting liners (36), if they have been removed, tap the liner into the cylinder about $\frac{1}{4}$ inch and make sure that it has been started straight. Then place a wooden block on the exposed end and drive liner the rest of the way into the cylinder. It is very important that these liners be properly located and the distance from the machined face of the pump body, at the point where the fluid cylinder head attaches, to the edge of the liner when properly located must be $1\frac{3}{16}$ inch.

Extreme care must be taken when installing liners. Make sure that they have been started straight, are driven in slowly to prevent buckling and distortion, and remove any burrs from the driven edge before assembling pistons.

Slide the fluid pistons (34) on the rods, making sure that they are flush against the shaft shoulder.

Slide one ring of fluid piston packing (48) on to each piston. This ring is solid and before it is mounted it should be cut diagonally. Take one more ring and make the diagonal cut. Then peel off enough of this ring so that the outside face of the second ring when installed will be $\frac{1}{8}$ inch short of filling the entire packing space on the piston head. This is to allow for expansion that will start to take place as soon as the unit is placed in operation.

Install piston followers (33) and special washers (32). Draw the followers up tight against the piston heads with the bronze piston rod nuts (31). Examine fluid cylinder head gasket (49) for breaks and then mount cylinder head (28), drawing capscrews up evenly until tight.

Using a wooden block, drive the valve seats (42) into the cylinder all of the way to the shoulder. After the four seats are installed, true up the tops with a file. Install suction valves (41) and grind them in in the same manner as described for the steam slide valves on Page 25, except that they are to be ground in with a rotary motion. Do the same with the discharge valves (39), installing valve springs (40) by sliding them over the stubs in the valve chamber cover (38). These valve springs are not essential to pump operation and their purpose is primarily to eliminate the noise due to the metal valves slamming shut. If the valve springs are broken and replacements are not available, throw out the broken spring and operate the unit without the spring until a replacement can be obtained. Check the valve chamber gasket for breaks and then install valve chamber (38).

Connect any lubricator, governor, steam inlet, suction or discharge piping that had been disconnected when disassembling.

42. Packing.

Fluid piston packing procedure is as described on Page 27, paragraph headed "Fluid End Assembly."

Piston rod boxes require $2\frac{1}{2}$ to 3 rings. The fluid rod boxes use a braided asbestos graphited packing. This is usually furnished in individual rings, cut to size, with a butt joint. Install one ring at a time, staggering the butt joints. Draw up the gland nuts tightly with wrench (2, fig. 11) and then back off a partial turn. The steam end rod boxes use a rubber and duck composition packing usually supplied with a lap cut. The installing procedure is the same as on the fluid end. Steam chest boxes use the same grade of packing as the steam rod box, but smaller in size and two rings per box. Install in the same manner as above, using gland nut wrench (4, fig. 11).

43. Miscellaneous.

The unit is now ready to operate and before starting be sure to follow starting instructions given on Page 10.

In assembling piping, use pipe joint compound on the threads, making sure that there are no chips or foreign matter in the pipe that could damage the inside of the pump.

Remember that the liner (36) and the piston rod boxes should not be removed from the unit unless it is absolutely necessary to replace them. Also remember when installing liners to locate them in the cylinder $1\frac{3}{16}$ inch from the machined face of the pump body to the end of the liner.

Usual extent of maintenance will consist of periodic oiling of valve gear, keeping lubricator filled and inspecting it for positive oil flow, replacing rod box and fluid piston packing when necessary. Under average conditions, no other part will require attention for two or three years with the exception of occasional grinding of steam and fluid valves.

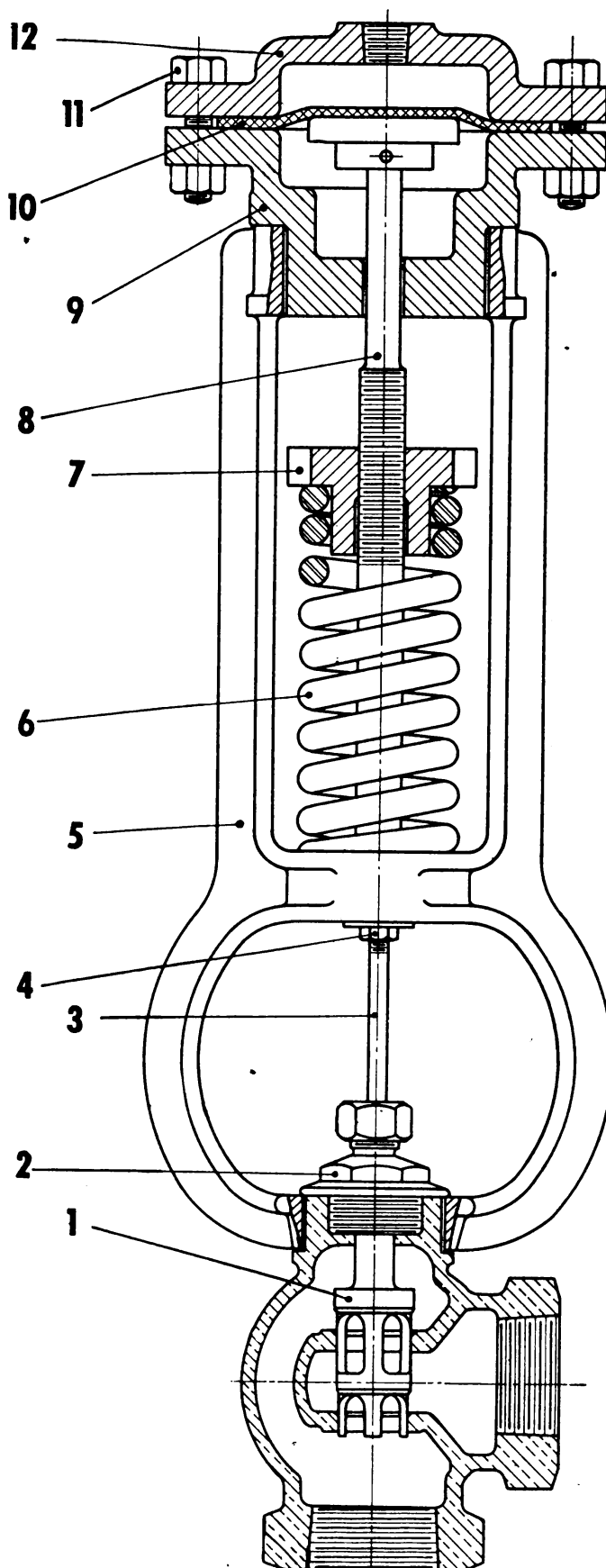


Fig. 13—Governor Assembly

GOVERNOR

44. General.

Before disassembling pump governor for repair, refer to fig. 13 for the various parts and reference numbers. The only parts subject to wear are the diaphragm (10), the valve disc (1) and the valve stem (3). The other parts will seldom, if ever, require replacement unless due to breakage from some abnormal condition.

45. Disassembly and Repair. (See fig. 13).

To replace the diaphragm (10), release the tension on the spring (6) by turning the adjuster (7) in a counter-clockwise direction, or, in other words, toward the diaphragm. Break the pipe union in the line from the diaphragm cover (12) to the pump, and then remove the six diaphragm cover bolts (11) and lift off the cover (12). The old diaphragm can then be lifted out and replaced by a new one.

To replace the spring, first release the spring tension as mentioned above and break the pipe union. Make a mark with a file or other sharp instrument on the stem (3) at the edge of the nut (4). Then when the nut (4) is loosened, the mark can be used as a guide in reassembling so as to draw the nut back up to its former position in relation to the stem (8). Unscrew the diaphragm chamber (9) as a unit, turning it in a counter-clockwise direction and remove it as a unit from the yoke (5). The stem (3) will then unscrew from the larger stem (8), and the diaphragm chamber, with the stem and adjusting nut, can be pulled upward out of the yoke so that the spring can be changed.

In reassembling the parts, proceed in reverse manner and draw up nut (4) to the mark made before disassembling so as to insure closing of the valve disc when the maximum operating pressure is on the diaphragm.

To disassemble valve disc (1) so as to grind it in or change it, release the spring tension as outlined above and break the union in the control line to the pump valve chamber. Loosen the locknut (4) and remove the box (2) by turning it in a counter-clockwise direction. Remove the two set screws holding the governor yoke to the valve body. By revolving the yoke (5), stem (3) and (8) will become disengaged and the yoke assembly can be lifted off. Then the disc (1) can be ground in the body in the same manner as described for the pump suction and discharge valves, Page 28.

It is recommended, when grinding, to use a compound of the same material as used for valve grinding on internal combustion engines. With both the disc and the valve seat clean, put pencil marks on each and rotate the disc (1) in its position. If the seats are properly ground in, these pencil marks will entirely disappear; and if they do not disappear, it will be necessary to continue grinding until the condition is corrected.

46. Adjustment and Lubrication.

Adjustment and lubrication of the governor is covered on Page 14 in the Operation Section.

When the governor has been disconnected for any purpose, such as repair, care should be taken in reassembling to the pump that the pipe fittings are clean and all pipe threads are smeared with pipe joint compound before installing.

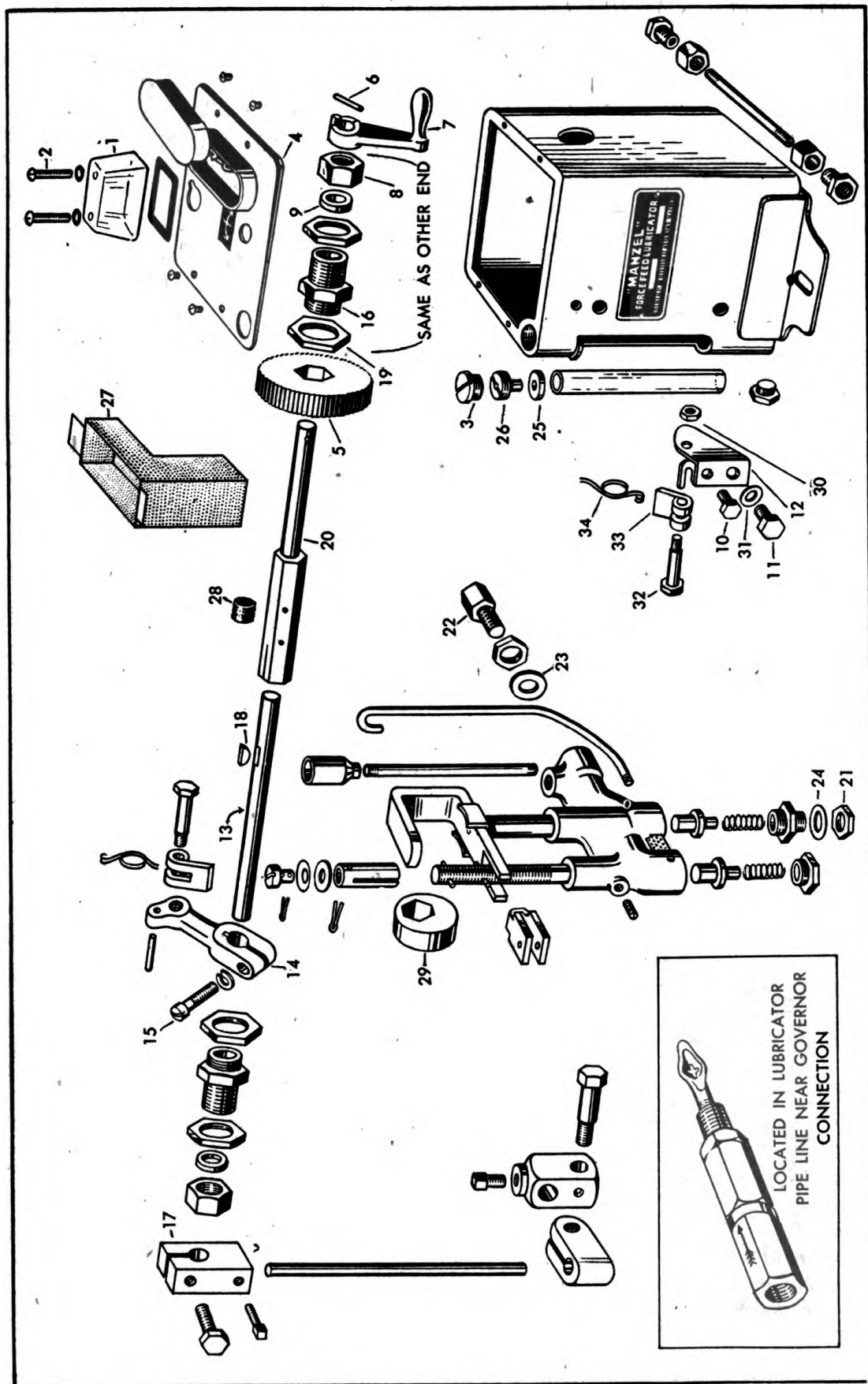


Fig. 14—Exploded View, Lubricator

LUBRICATOR

47. General.

Lubricator has very few parts that will require replacement other than from unforeseen accidents. As long as the lubricator pumps sufficient oil, it is not necessary to replace any part and the operator can always see through the sight glass just how much oil is being supplied. Inspecting of parts for wear would be of little value because even if they were worn slightly the plunger stroke could be increased to compensate for the wear. Just as long as any oil is going through the sight glass, the operator will know that the lubricator is operating satisfactorily.

The only parts on which wear has any effect in the operation of the lubricator are the plunger, piston valves and the cylinder in which these parts operate. The amount of wear that can be allowed before these parts must be replaced depends upon the grade of oil used and the steam pressure. Pumping against higher steam pressures than mentioned previously and/or using an oil lighter than OE-50 will cause the need for earlier replacement than when operating against previously mentioned pressure and handling OE-50 oil.

48. Disassembly. (See fig. 14).

Remove sight feed glass (1), cover screws (2) and gauge glass cap plug (3). This permits the removal of the lubricator cover (4).

Before doing any further disassembling, examine very carefully the arrangement of the parts as assembled in the reservoir and refer to the exploded view (fig. 14). Note in particular the position of the ratchet wheel teeth (5) so that in reassembling this can be located in the same position.

Remove the hand crank pin (6) on the end of the shaft and remove the hand crank (7). Remove the packing nuts (8) from the stuffing boxes on each side of the lubricator. The packing washers (9) will remain on the shaft until both stuffing boxes (16) are removed. Remove the two capscrews (10 and 11) to permit the removal of the ratchet wheel brake (12).

Turn the ratchet shaft (13) so that the inside rocker arm (14) is in a position to permit the fillister head screw (15) in the rocker arm to be loosened. Remove the stuffing boxes (16) together with washers and nuts at each end of the reservoir and place the packing washers (9) in the packing nuts (8) which were previously removed. Now remove the inside rocker arm (14) from the ratchet shaft. This can be done by putting arm (17) back on to the ratchet shaft and tap this arm until the ratchet shaft is released from the inside rocker arm. There is a small Woodruff key (18) holding the inside rocker arm on the ratchet shaft. The stuffing box jam nuts (19) on the inside will now be free for removal. Remove the eccentric shaft (20) by forcing it through the ratchet wheel (5) from the hand crank end. This will release the ratchet wheel and the other stuffing box jam nut (19).

To remove the pumping unit, which must come out as an assembly (fig. 7, Page 15), the nut (21) on the bottom of the reservoir and the nut (22) on the outlet connection at the rear of the reservoir should be removed. A 1/16-inch thick fiber washer (23) is used between the pumping unit and the inside of the reservoir at the outlet connection. A 1/32-inch thick fiber washer (24) is used between the pumping unit and the inside of the reservoir at the bottom fastening connection.

This completes the disassembling.

49. Assembly.

Install the pumping unit in the reservoir by placing it through the hole in the bottom of the reservoir and in line with the outlet connection. Install the two washers and nuts mentioned above. In connection with the pumping unit, the construction is such that this should not be dismantled and if it requires replacement will have to be ordered as a complete assembly. If any plungers, cylinder and

valves require replacement, they must be ordered as an assembly (1700) as covered in the parts manual; or, if a complete pump assembly is desired as outlined in the parts manual, this is specified as part 1700-B.

Install the eccentric shaft (20) by placing it through the drive hole in the reservoir, through the ratchet wheel (5) and then the pumping unit eccentric (29) and through the stuffing box jam nut (19) with the smooth face of the jam nut toward the outside, and then through the hole in the reservoir at the hand crank end.

Install ratchet shaft (13) by placing it through the driven end hole, then through the other stuffing box jam nut (19), keeping the smooth face of the jam nut toward the outside, and then into the inside rocker arm. Be sure that the Woodruff key is in place on the ratchet shaft so that it fits into the keyway on the rocker arm and that the felt packing (28) is in place in the eccentric shaft.

Replace both stuffing boxes (16) and packing nuts, which should contain the packing washers (9) before assembling, and tighten the fillister head screw (15) in the inside rocker arm.

Attach the assembled ratchet wheel brake (these parts are shown in the lower right-hand corner of fig. 14, Parts 10, 11, 12, 30, 31, 32, 33 and 34). Be sure that the washer (31) is put on with the larger capscrew (11). Then replace the hand crank (7) and hand crank pin and attach the cover to the reservoir, making sure that the regulating fork attached to the cover on the under side fits over the regulating plunger on the pumping unit. Replace the gauge glass cap plug (3) and sight feed glass (1).

50. Adjustment.

Adjustment of the lubricator is covered on Page 17 in the Operating Section.

51. Miscellaneous.

Should leakage occur in the bottom or top of the gauge glass, the gauge glass washers (25) can be tightened by unscrewing the cap plug (3) above the gauge glass and tightening up on the small plug (26). This can be done without removing the cover from the reservoir.

At 256-hour periods, or once a month, it is advisable to remove the cover and take out the strainer (27) and clean.

POINTS TO REMEMBER

52. The pump unit together with the governor and the lubricator are so constructed that maintenance is kept at a bare minimum. We cannot stress too greatly the fact that this complete unit will require very little replacement and never requires replacement until the piece is completely worn out.

The operator will find it to his advantage to leave the unit alone and not be tearing it apart for unnecessary inspection. By careful lubrication and the following of instructions as to lubrication, occasional valve grinding in the pump and governor and reasonable care in keeping the external linkage clean will mean that the unit will give trouble-free operation for many years.

